

THE WEATHER AND CIRCULATION OF SEPTEMBER 1952<sup>1</sup>

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The circulation over North America and adjacent oceans was dominated by two vastly different long wave patterns in September 1952. During the first half of the month abnormally strong ridges were located over eastern North America and the eastern Pacific while a mean trough was found near the West Coast (fig. 1a). The circulation pattern over these same regions in the second half of September (fig. 1b) represented a reversal in phase of the waves from the first half of the month. In approximately the positions previously occupied by the two strong ridges abnormally deep troughs were now located, while a well-developed ridge dominated western North America.

Although detailed treatment of evolution of circulation patterns is beyond the scope of this paper, it is interesting to point out some of the probable factors associated with these changes in circulation. In the first half of September an extremely short wave length existed between a trough over eastern Asia (only partly shown in fig. 1a) and a trough extending southeastward from Kamchatka to the west central Pacific. During the course of the month the Asiatic trough moved eastward to a more normal position along the coast and the westerlies increased as the abnormally strong blocking ridge in the Bering Sea and eastern Pacific weakened. The western Pacific trough then moved rapidly eastward and a dynamically more satisfactory wave spacing resulted by the second half of the month (fig. 1b). As this trough moved eastward it joined with a slowly retrograding minor high-latitude trough in the Gulf of Alaska. Consequently, during the second half of September a very deep trough extended from Alaska southward into the east central Pacific. The deepening was probably aided by an outpouring of cold Arctic air across Alaska into the Gulf of Alaska, which had already set in during the first half of the month. This abnormal flow out of Alaska and the Arctic in both halves of September is clearly indicated by the orientation and strong gradients of the height anomaly lines in that region as shown in figure 1. Once this deep trough became established in the eastern Pacific rapid readjustment of the wave pattern over North America took place with development of a strong ridge over the West and a deep trough over the East.

The contrasting circulation patterns of the two halves

of September were well related to some interesting differences in temperature regimes over the United States during the two halves of the month (fig. 2). In the first half of the month (fig. 2a) abnormally warm weather prevailed over the northern half of the country east of the Rockies and over much of the Southwest in association with above normal heights at 700 mb. (fig. 1a). The more extreme positive temperature anomalies were generally located in regions (e. g., the Great Lakes, the Dakotas, eastern Nevada) where mean 700-mb. heights were markedly above normal and/or flow was more southerly than normal. On the other hand, cool weather occurred in the western and northern Plateau region where the area of below-normal temperatures practically coincided with the region of negative height anomaly surrounding the western trough. Temperatures were also below normal in the southern tier of States from South Carolina to east Texas even though 700-mb. heights were above normal. However, the prevailing easterly flow (stronger than normal) south of the mean 700-mb. high cell centered over western Virginia, the predominance of polar air in this flow at sea level, and the weak easterly trough in the Gulf of Mexico accounted for cool weather in the South.

The temperature regime in the latter half of September (fig. 2b) was markedly different from that of the first half in several sections of the country. The most striking change was in the Far West where temperatures were much in excess of normal in contrast to below-normal values shown in figure 2a. This heat wave was closely associated with the strong western ridge which was most abnormal over the Pacific Northwest directly over the region of maximum positive surface temperature anomaly. It is noteworthy that coastal stations along much of the West Coast had temperatures near or below normal in this period in contrast to the extreme heat inland. The reverse pattern of temperatures (i. e., warm on the coast, cool inland) occurred in the first half of September. These inverse relationships between coastal and inland temperatures are explainable in terms of the sea breeze circulation, which is stronger when the land areas are warm relative to the ocean (producing cool weather on the coast) and weaker when land areas are cooler relative to the ocean (resulting in warm weather on the coast).

The prevailing temperature anomaly also changed markedly between the two halves of September in the

<sup>1</sup> See Charts I-XV following page 163 for analyzed climatological data for the month.

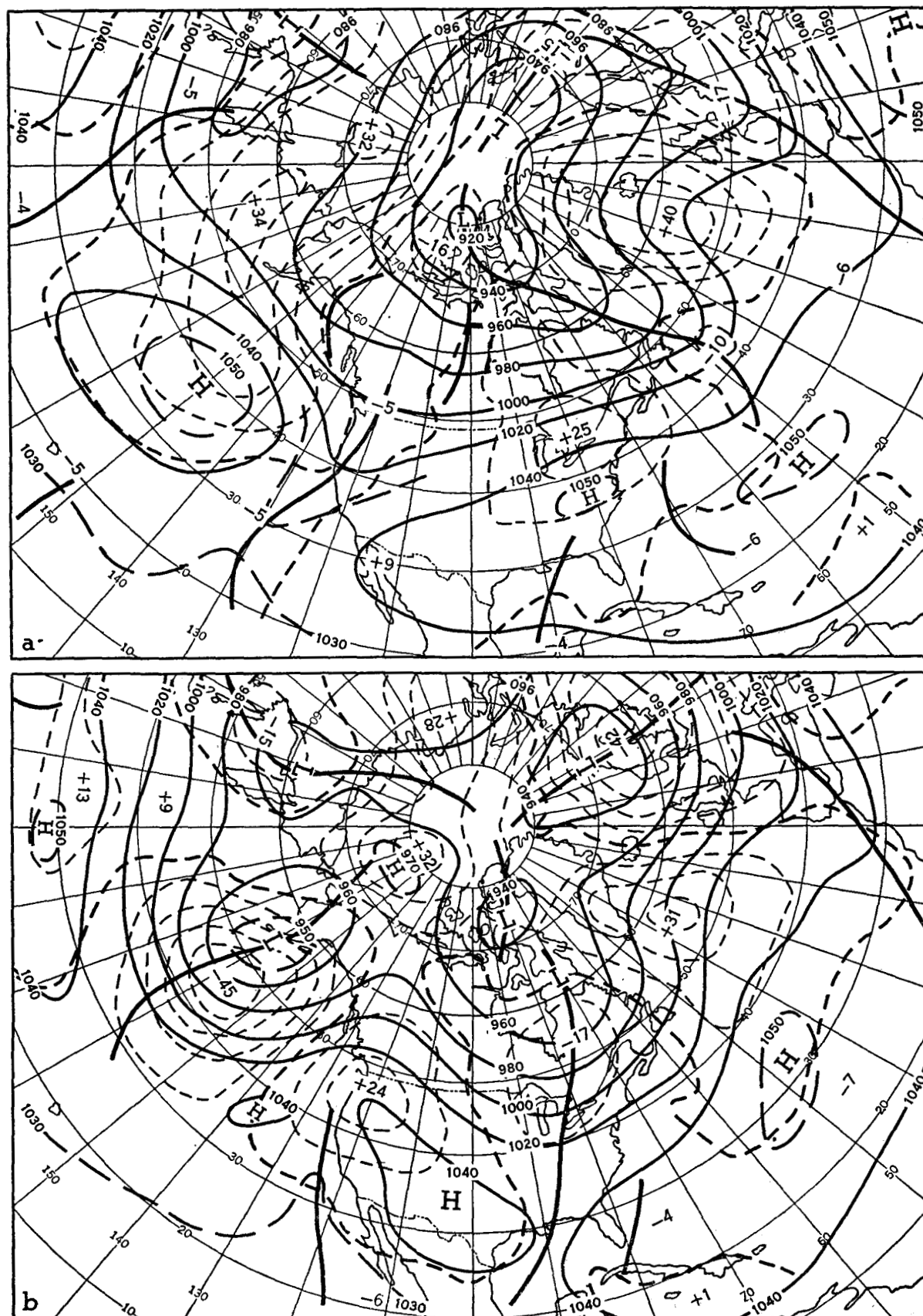


FIGURE 1.—Fifteen-day mean 700-mb. charts for (a) August 31–September 14, and (b) September 14–28, 1952, illustrating the marked change in circulation regime over the North American region during September. Height anomalies at 100-ft. intervals are shown by short dashed lines and anomaly centers are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

Great Lakes region, the Ohio Valley, and much of the Northeast. Below-normal temperatures were generally observed in these areas during the second half of the month in association with the well-developed mean trough located over the Lakes and the Ohio Valley (fig. 1b). Stronger-than-normal northerly flow between this trough and the western ridge led to frequent outbreaks of cool Canadian polar air into the eastern United States. Examination of Chart IX indicates that the bulk of the migrating high cells passed through the eastern half of the United States during the second half of the month following a cyclonic trajectory closely resembling the mean 700-mb. contours in figure 1b.

Prevailing temperature anomalies in some sections of the country remained quite similar throughout September. In particular, these areas were the Rocky Mountain region, the Plains States, the Southeast, and the extreme East Coast. This persistence, in spite of large changes in circulation pattern over these areas, demonstrates that the same temperature anomaly over limited regions occasionally can be associated with two or more differing circulation regimes.

The mean temperature anomalies for the month as a whole (Chart I-B) exhibited a rather well-defined pattern, largely because of the areas where persistence of 15-day temperature anomaly occurred, and also because the heat wave in the Far West in the latter half of the month was so extreme as to greatly overcompensate the cool weather early in the month. The relationship of these monthly temperature anomalies to the monthly mean 700-mb. circulation pattern (fig. 3) was fairly good even though the monthly mean 700-mb. wave pattern over North America and adjacent areas was a very poorly defined one owing to the diverse circulation regimes which made it up. Height anomalies over these regions were generally small with little horizontal variation so that the flow with respect to normal was rather weak. Nevertheless the prevalence of generally above normal heights over most of the United States was in agreement with the predominantly warm weather observed over the nation during the month.

Precipitation amounts were predominantly subnormal over the United States during September (Chart III). In fact, in approximately half of the nation rainfall was less than 50 percent of normal (Chart III-B). Both contrasting circulation regimes prevailing during the month were associated with this generally dry regime, with minor contrasts, largely because neither circulation pattern produced a strong influx of moisture from either the Gulf of Mexico or the Pacific source regions. This was equally true of the monthly mean circulation pattern. Thus, areas of heavier-than-normal precipitation were generally relatively small and surrounded by more extensive areas of subnormal precipitation. Many of these areas of abnormally heavy rainfall were the result of concentrated

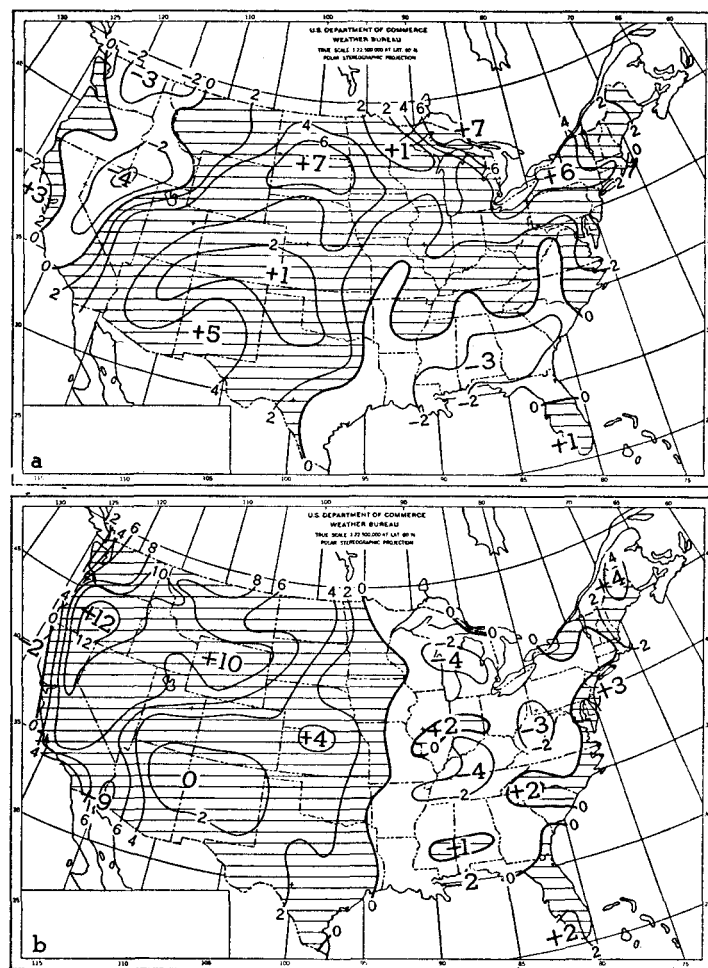


FIGURE 2.—Departure from normal (approximate) of 15-day mean surface temperatures in ° F. for periods (a) September 1-15, and (b) September 16-30, 1952.

rains occurring during only a few days, and hence were poorly related to either the 30-day or 15-day mean circulation patterns. This was true of the unusual rains in the Southwest which extended eastward from southeastern California and southern Nevada into west Texas between the 19th and 23d.<sup>2</sup> Similarly, some extremely heavy drought-breaking rains occurred in a belt approximately 100-150 miles wide from the Gulf Coast through central Texas on the 9th, 10th, and 11th in association with strong southeasterly flow on these days.<sup>3</sup> In some spots in central Texas rainfall on these days reached flood-producing totals of 10 to 20 inches. But meanwhile other regions of Texas remained drought-ridden. In the valleys of the Rio Grande and the Red River, rainfall totaled less than 25 percent of normal for the month as a whole. Only in the vicinity of and to the east of the mean troughs located over the Mississippi Valley and the Far West (fig. 3) were

<sup>2</sup> See article by Roe and Vederman on p. 156 of this issue.

<sup>3</sup> See article by Lott on p. 161 of this issue.

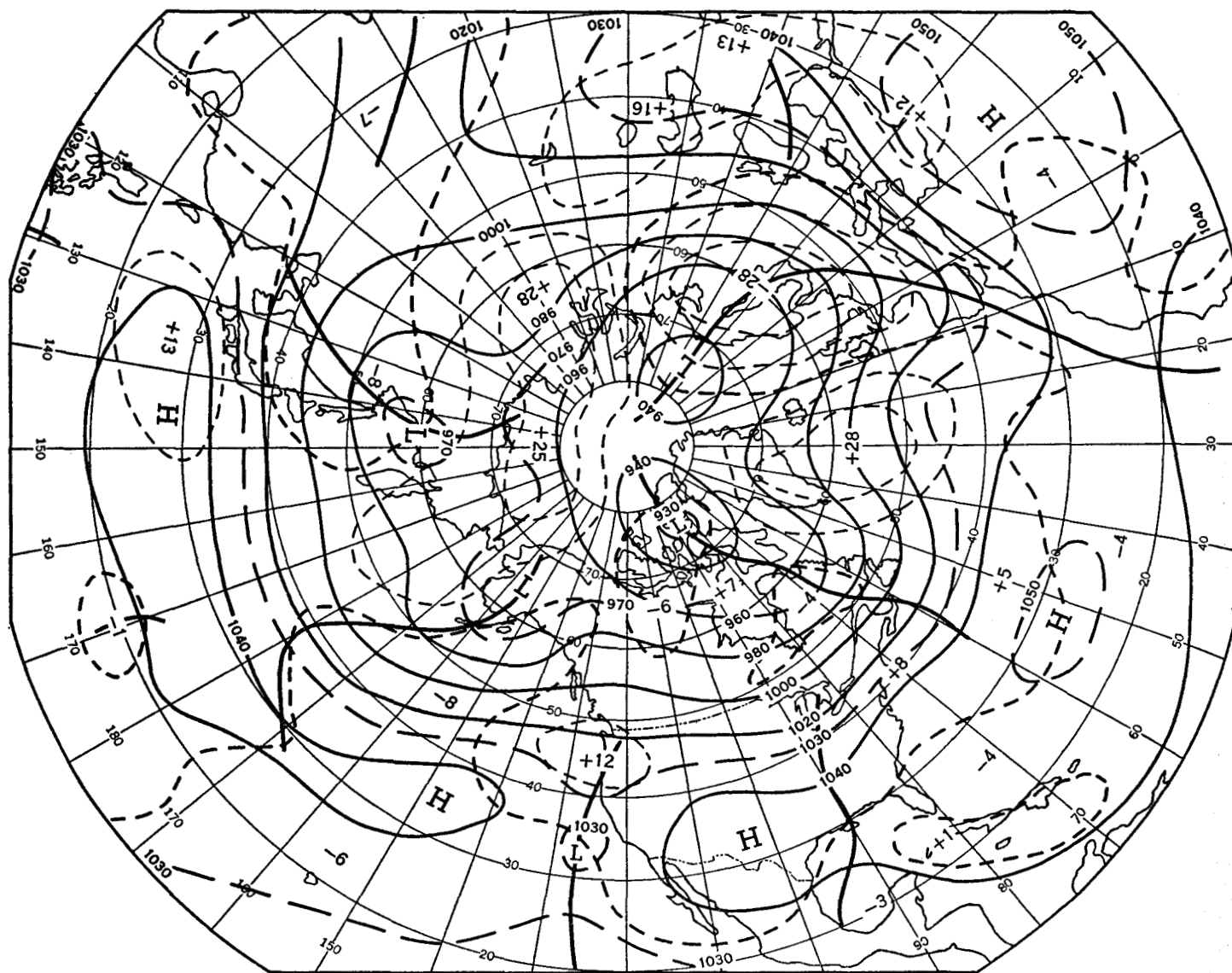


FIGURE 3.—Mean 700-mb. chart for the 30-day period August 30-September 28, 1952. Height anomalies at 100-ft. intervals are shown by short dashed lines and anomaly centers are labeled in tens of feet. Minimum latitude trough locations are shown by heavy solid lines.

the heavier-than-normal precipitation areas made up by precipitation occurring in more than one week of the month. But even in these sections areas of subnormal rainfall were much greater in extent than the areas of supernormal rainfall.

Figure 4 and Chart X appear to throw further light on why precipitation was so predominantly subnormal over much of the country in September. Over most of the United States the monthly mean relative vorticity at 700 mb. was anticyclonic and very few cyclones appeared within the nation's borders. Rather, the country was dominated by anticyclones (Chart IX). By way of contrast, cyclonic activity was very frequent across

Canada, especially over the northern and eastern areas where cyclonic vorticity prevailed aloft in relatively flat westerly flow. These storm tracks were also fairly well delineated by the mean sea level chart (Chart XI). It is especially noteworthy that practically all cyclones moving eastward across Canada into the Atlantic or the Davis Strait remained in the region of mean cyclonic vorticity, while virtually all anticyclones crossing North America exited through the North Atlantic States or stalled near the Appalachians where anticyclonic vorticity was at a maximum.

Further comparison of Charts IX and X with figure 4 reveals a rather close association of daily cyclone and



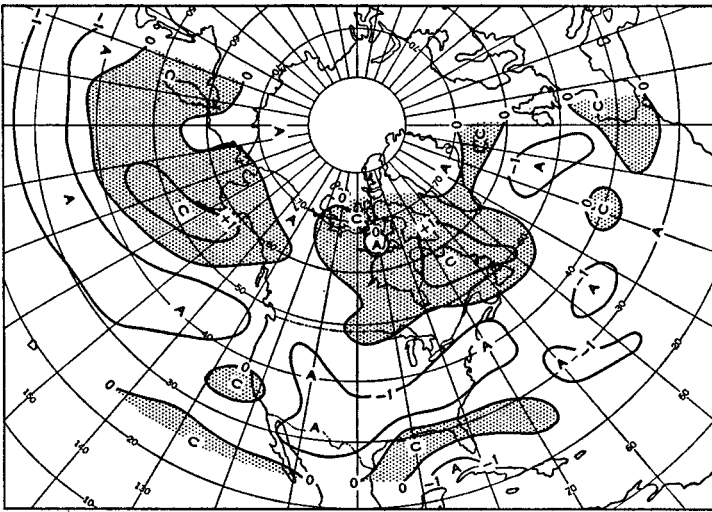
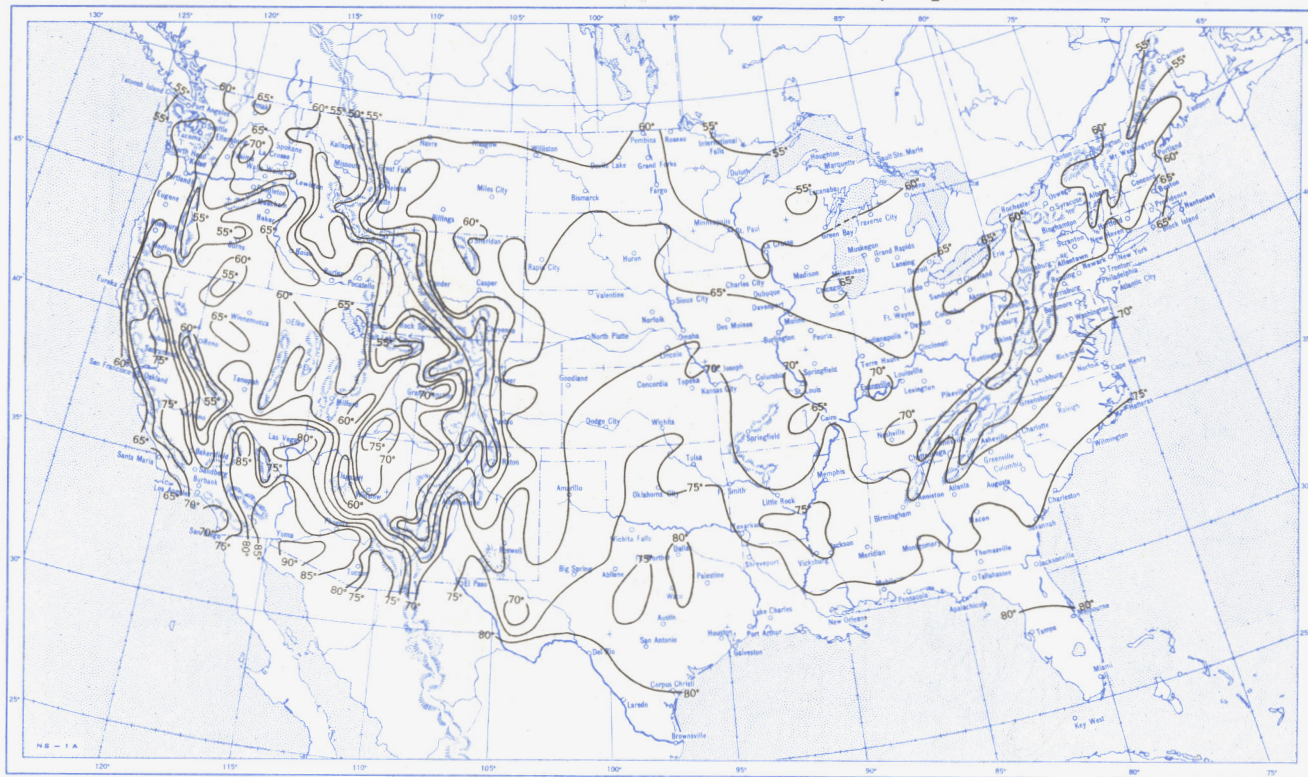
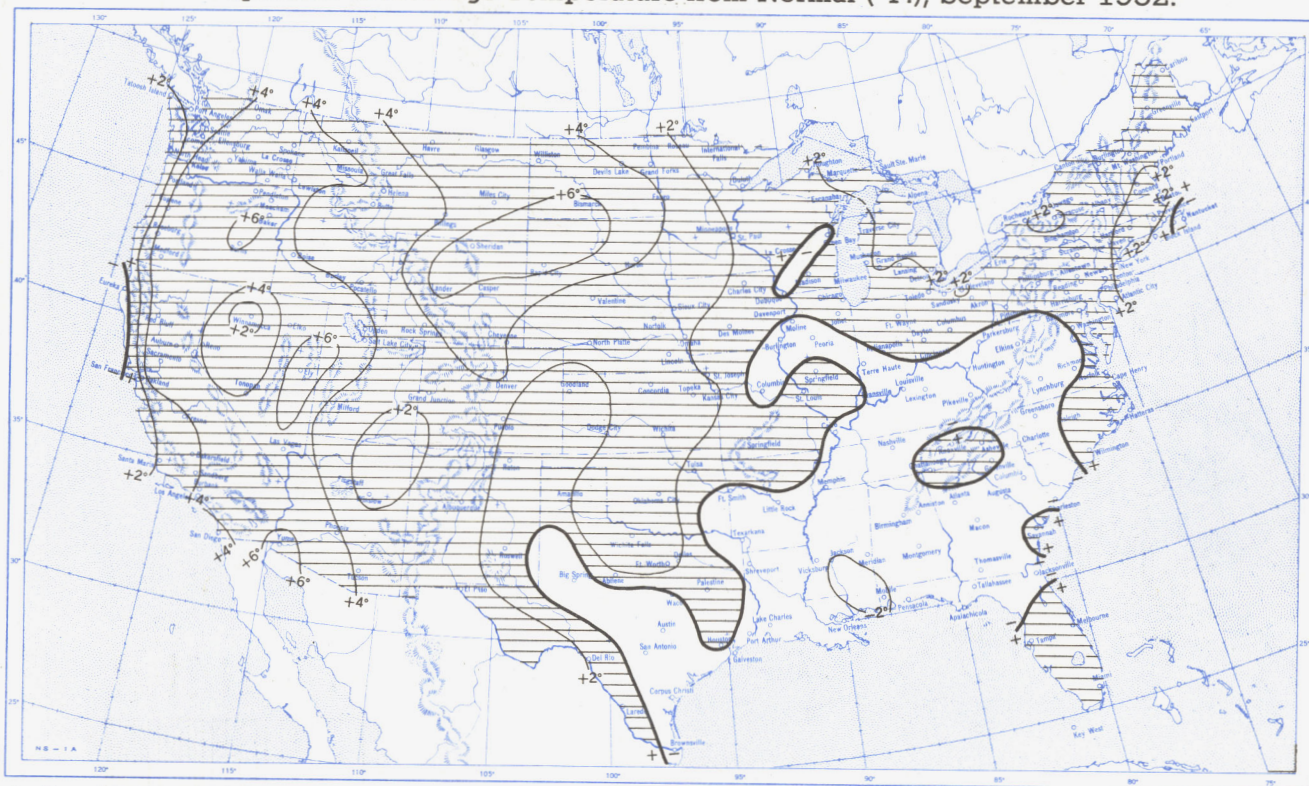


FIGURE 4.—Mean relative geostrophic vorticity at 700 mb. for the 30-day period August 30–September 28, 1952, in units of  $10^{-8} \text{ sec}^{-1}$ . Areas of cyclonic vorticity are shaded and labeled "C" at centers of maximum vorticity. Areas of maximum anticyclonic vorticity are labeled "A."

anticyclone tracks with regions of 700-mb. monthly mean cyclonic and anticyclonic vorticity, respectively, in the eastern Pacific. In the eastern Atlantic cyclones were generally blocked from progressing eastward between  $40^\circ$  and  $60^\circ \text{ N}$ . This was associated with a persistent abnormally strong ridge at 700 mb. and sea level (figs. 1 and 3 and Chart XI) which had strong anticyclonic vorticity (fig. 4). Downstream from this ridge was an equally strong trough over Europe. The strong northerly flow with respect to normal between these two systems at both sea level and aloft (Chart XI inset and fig. 3) was accompanied by some of the coldest September weather over Europe in recent history.

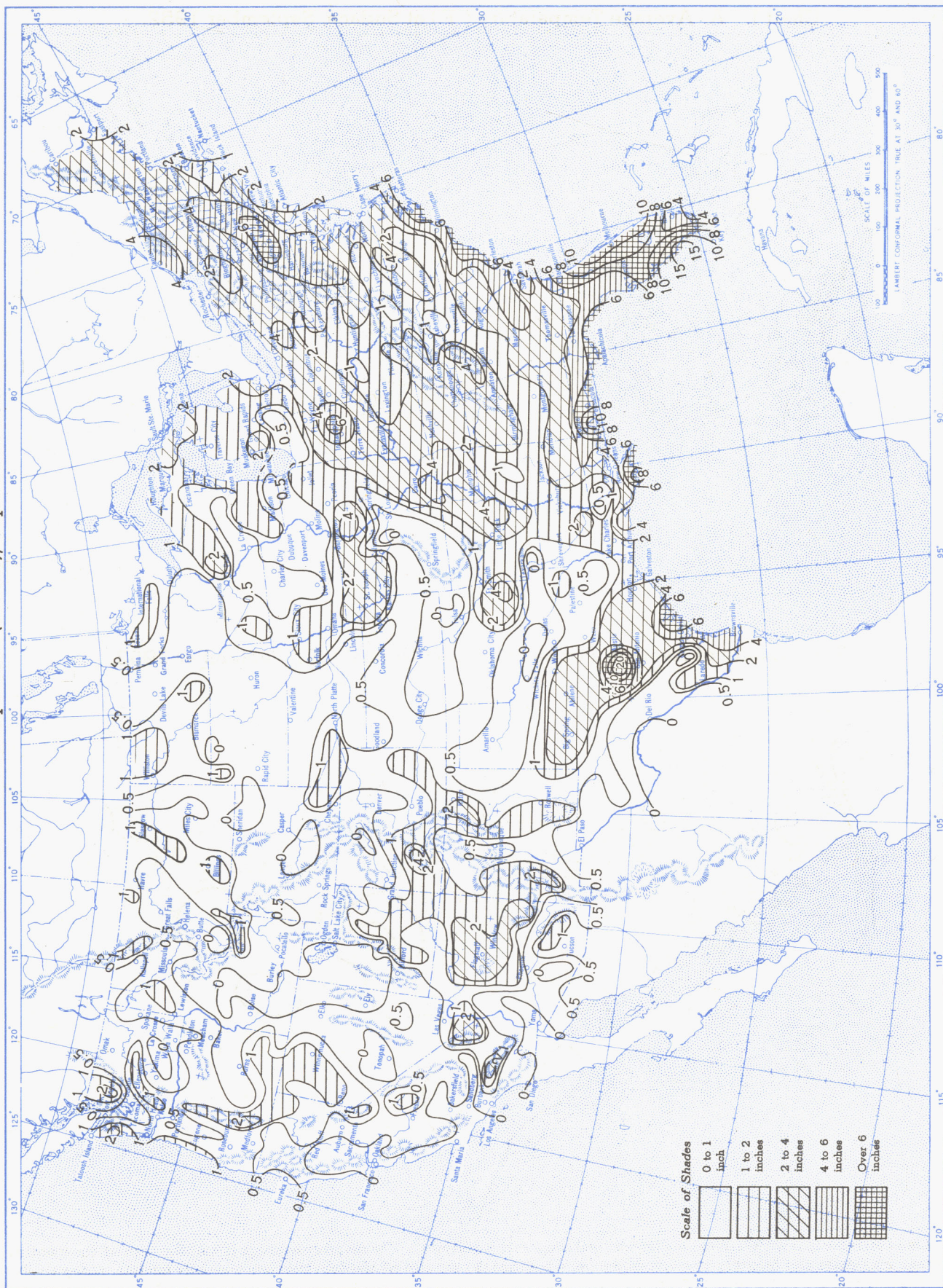
Chart I. A. Average Temperature ( $^{\circ}\text{F.}$ ) at Surface, September 1952.B. Departure of Average Temperature from Normal ( $^{\circ}\text{F.}$ ), September 1952.

A. Based on reports from 800 Weather Bureau and cooperative stations. The monthly average is half the sum of the monthly average maximum and monthly average minimum, which are the average of the daily maxima and daily minima, respectively.

B. Normal average monthly temperatures are computed for Weather Bureau stations having at least 10 years of record.



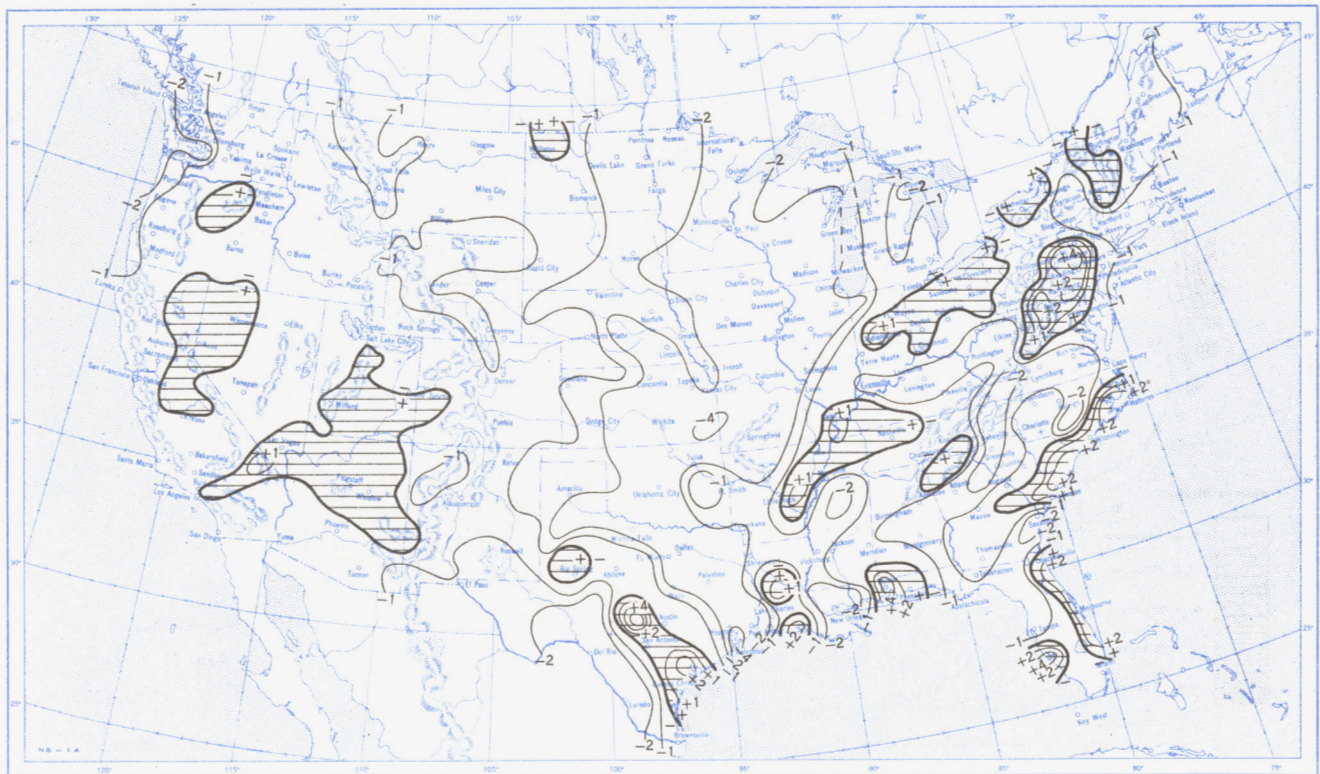
Chart II. Total Precipitation (Inches), September 1952.



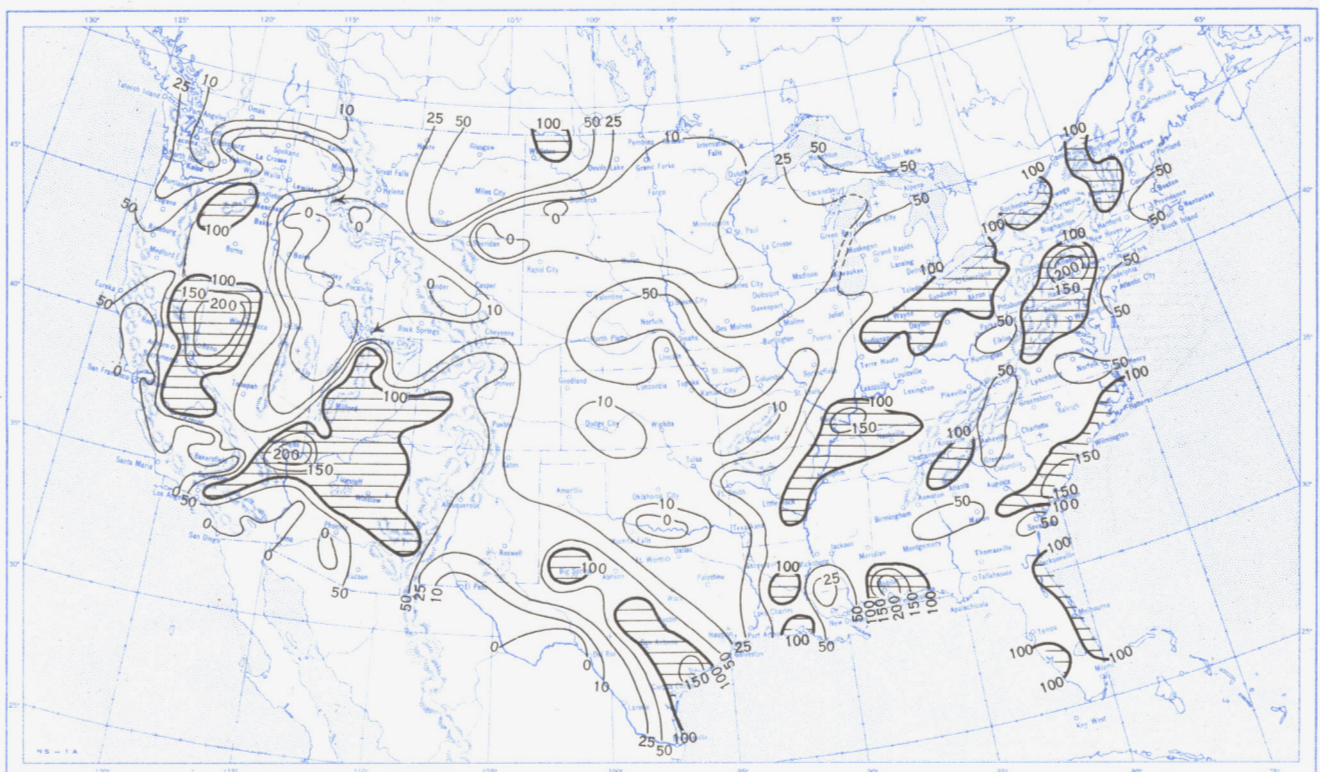
Based on daily precipitation records at 800 Weather Bureau and cooperative stations.



Chart III. A. Departure of Precipitation from Normal (Inches), September 1952.



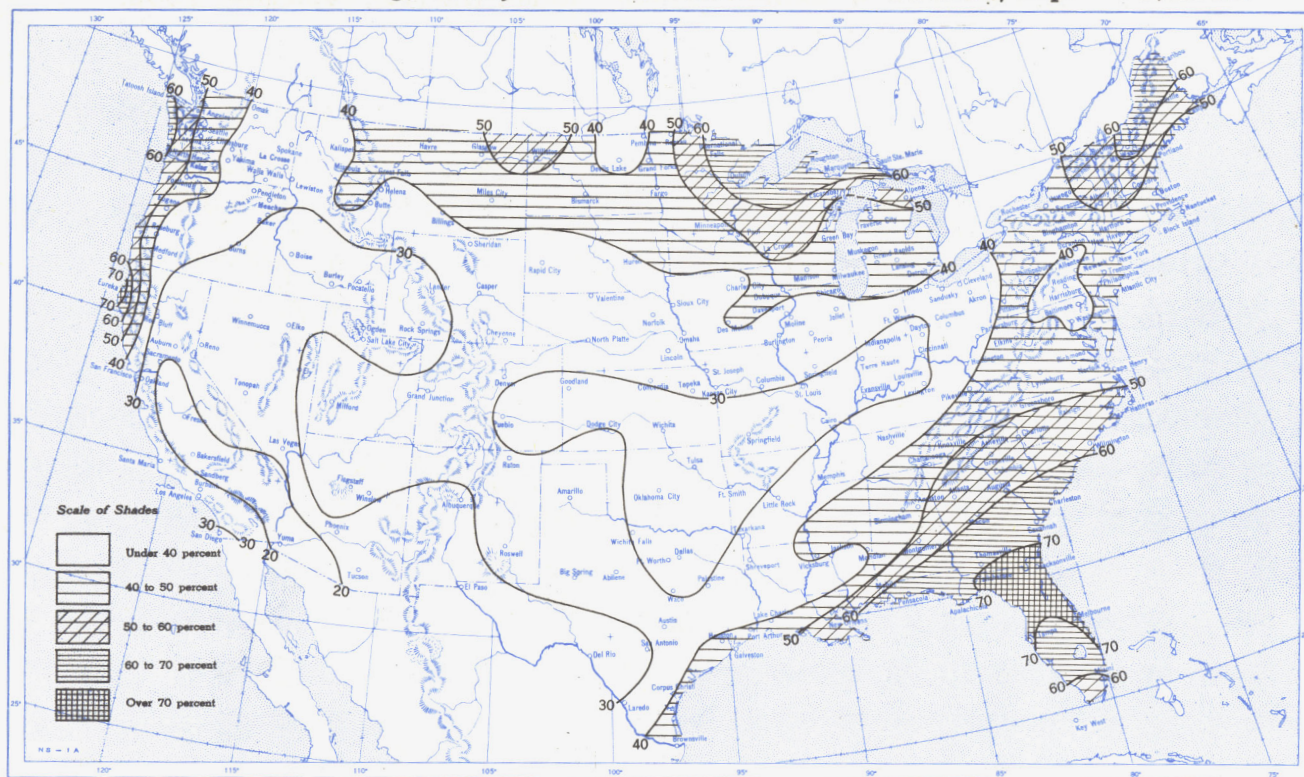
B. Percentage of Normal Precipitation, September 1952.



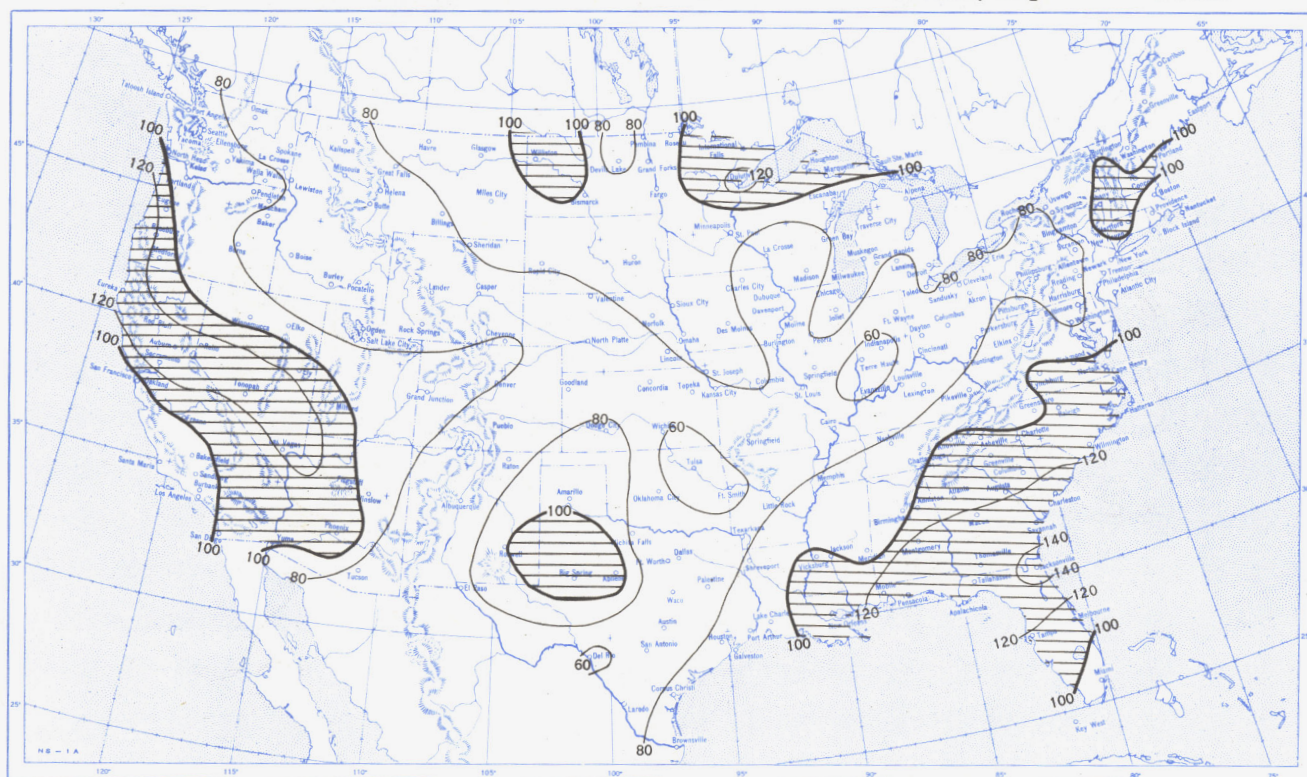
Normal monthly precipitation amounts are computed for stations having at least 10 years of record.



Chart VI. A. Percentage of Sky Cover Between Sunrise and Sunset, September 1952.



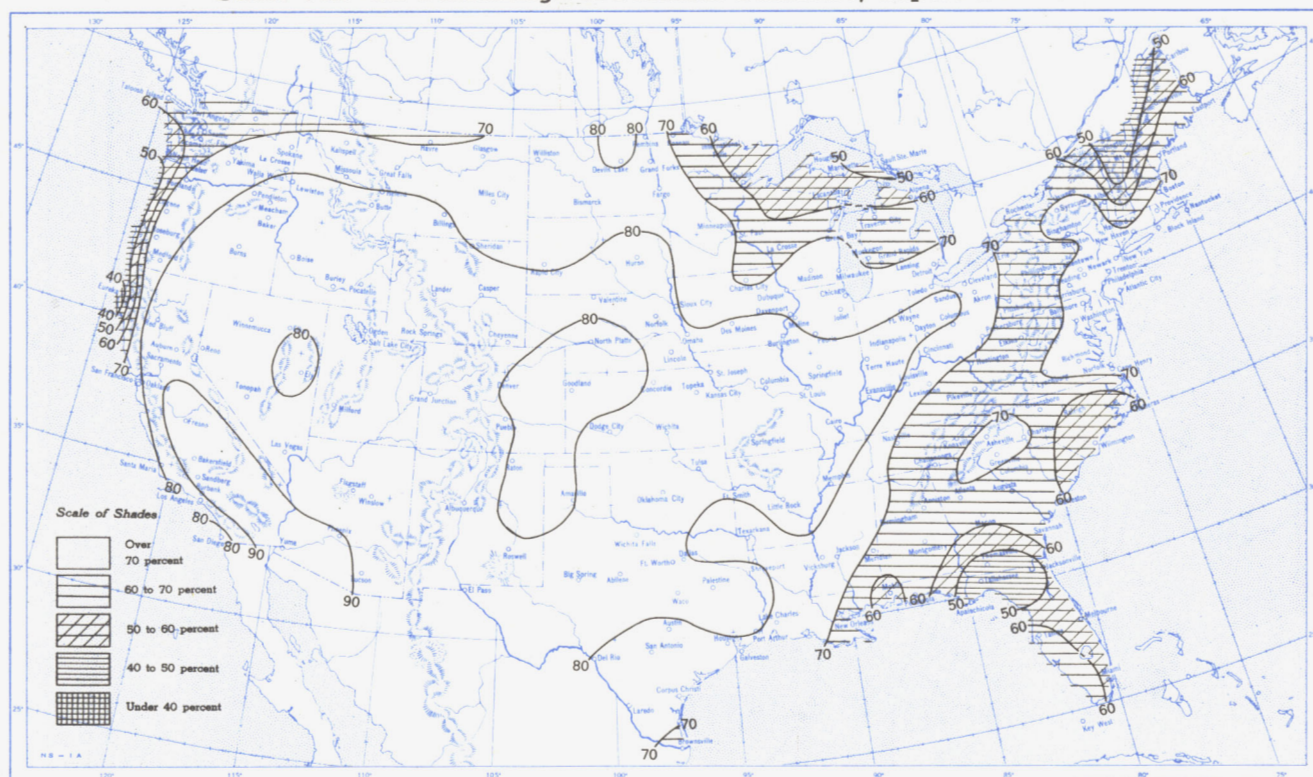
B. Percentage of Normal Sky Cover Between Sunrise and Sunset, September 1952.



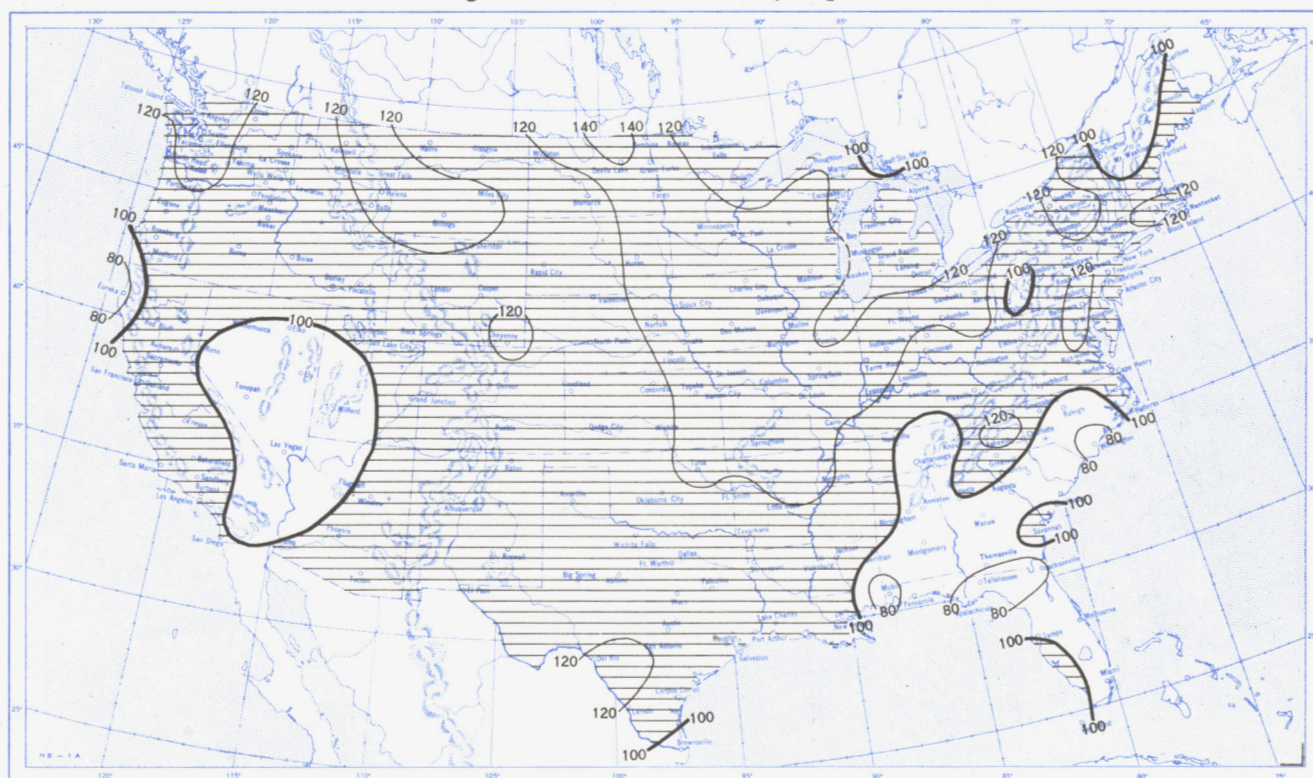
A. In addition to cloudiness, sky cover includes obscuration of the sky by fog, smoke, snow, etc. Chart based on visual observations made hourly at Weather Bureau stations and averaged over the month. B. Computations of normal amount of sky cover are made for stations having at least 10 years of record.



Chart VII. A. Percentage of Possible Sunshine, September 1952.



B. Percentage of Normal Sunshine, September 1952.



A. Computed from total number of hours of observed sunshine in relation to total number of possible hours of sunshine during month. B. Normals are computed for stations having at least 10 years of record.



Chart VIII. Average Daily Values of Solar Radiation, Direct + Diffuse, September 1952. Inset: Percentage of Normal Average Daily Solar Radiation, September 1952.

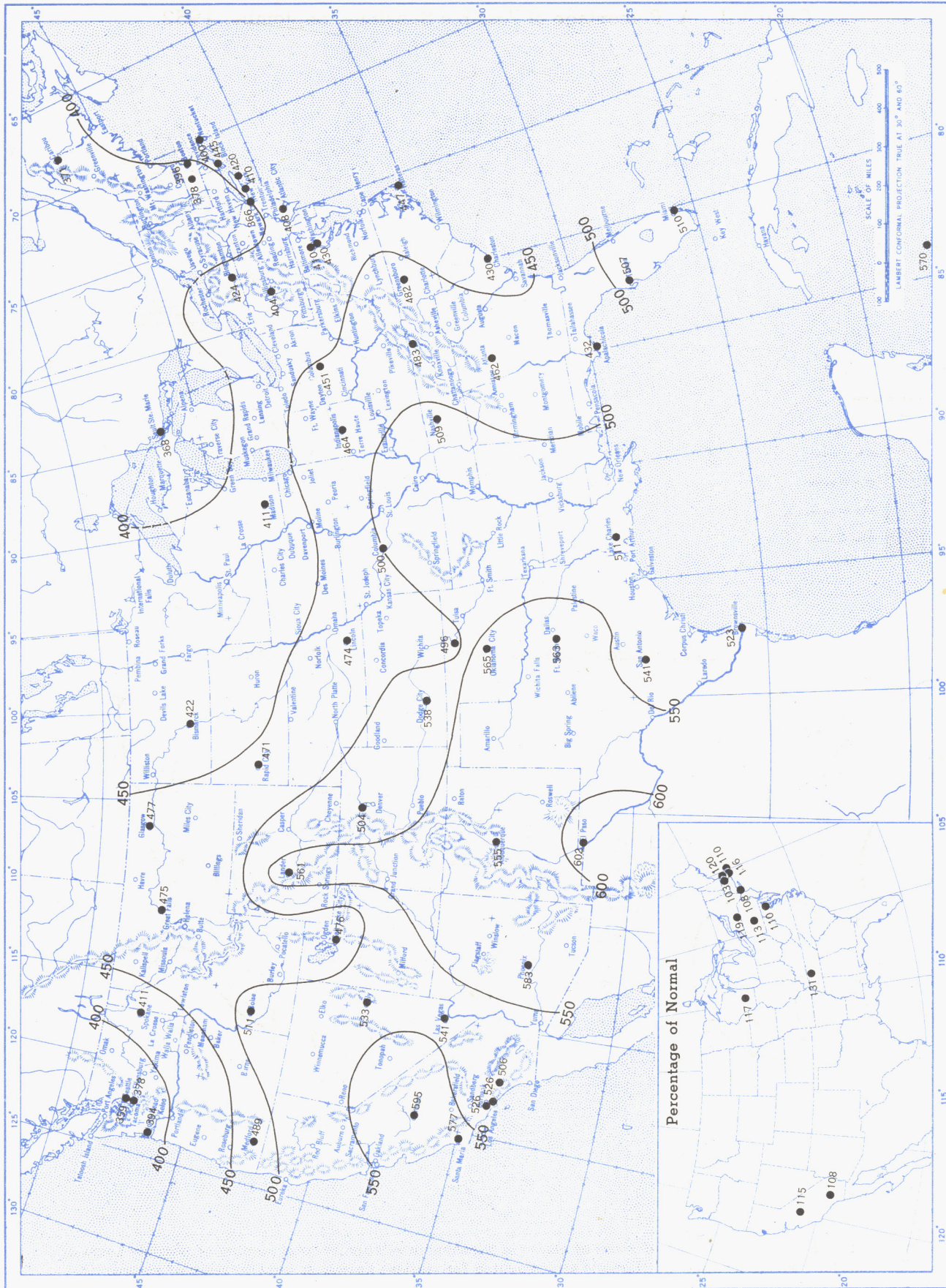
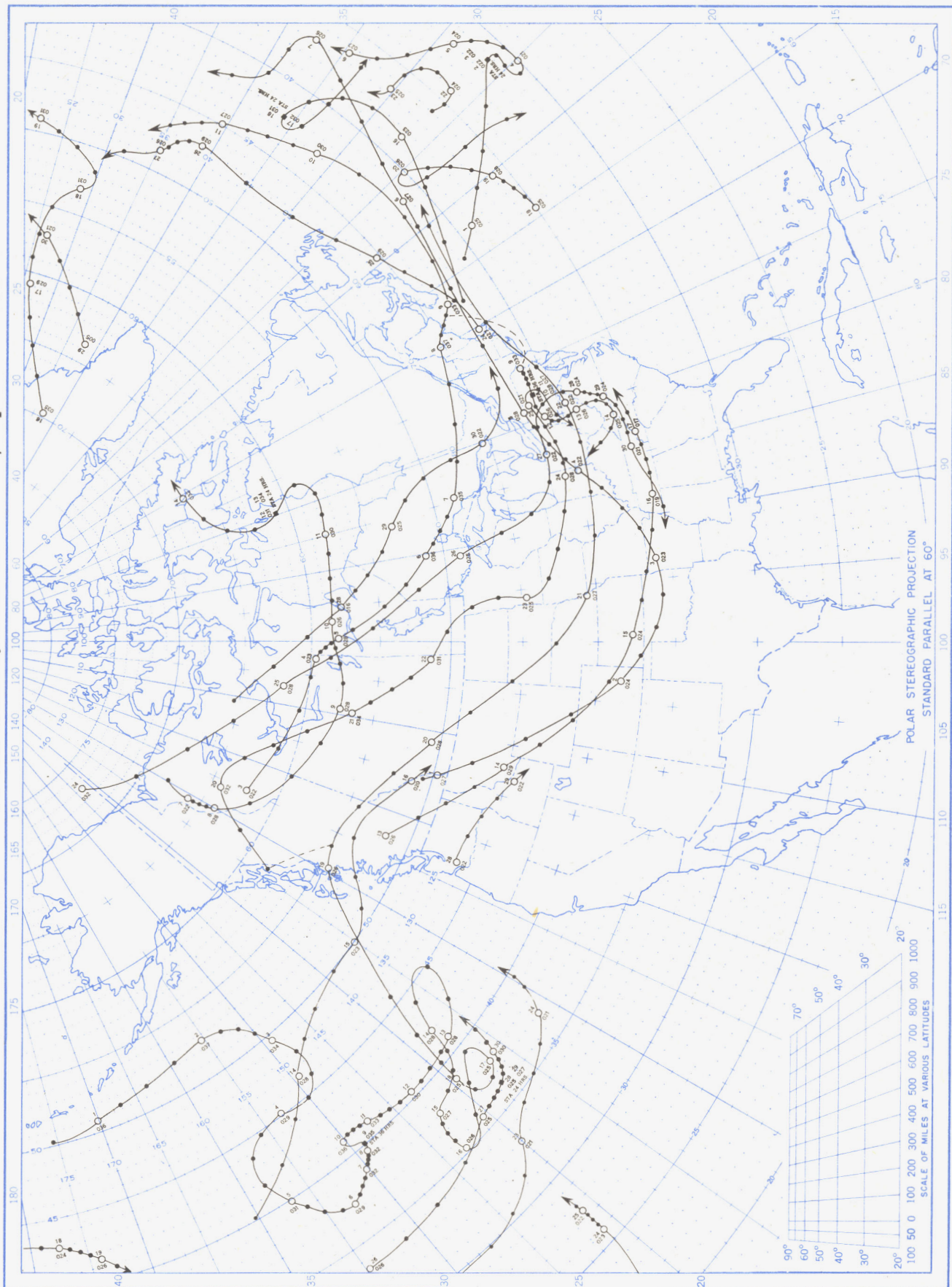


Chart shows mean daily solar radiation, direct + diffuse, received on a horizontal surface in langley (1 langley = 1 gm. cal. cm.  $^{-2}$ ). Basic data for isotherms are shown on chart. Further estimates are obtained from supplementary data for which limits of accuracy are wider than for those data shown. Normals are computed for stations having at least 9 years of record.



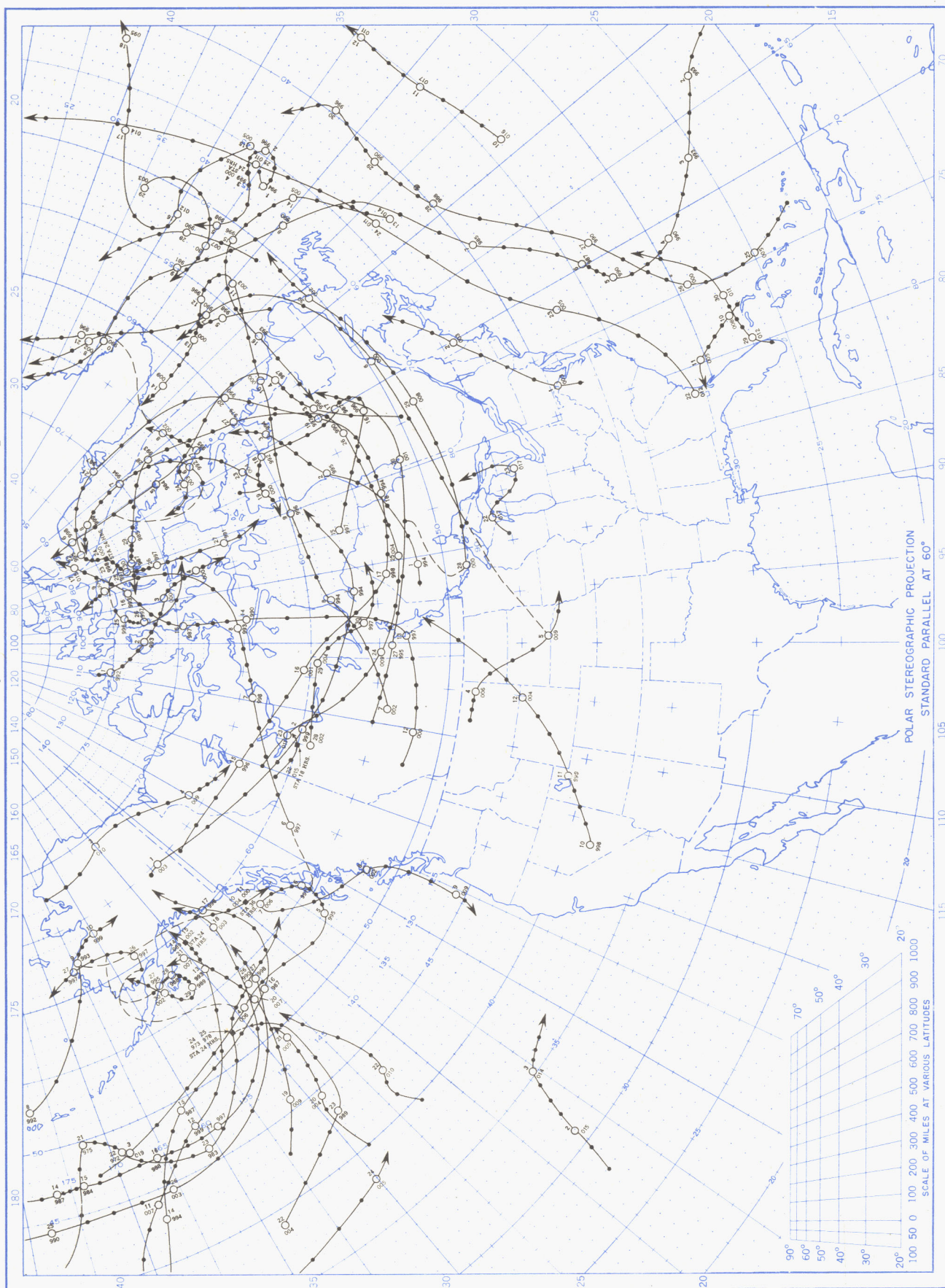
Chart IX. Tracks of Centers of Anticyclones at Sea Level, September 1952.



Circle indicates position of center at 7:30 a. m. E. S. T. Figure above circle indicates date, figure below, pressure to nearest millibar. Dots indicate intervening 6-hourly positions. Squares indicate position of stationary center for period shown. Dashed line in track indicates reformation at new position. Only those centers which could be identified for 24 hours or more are included.



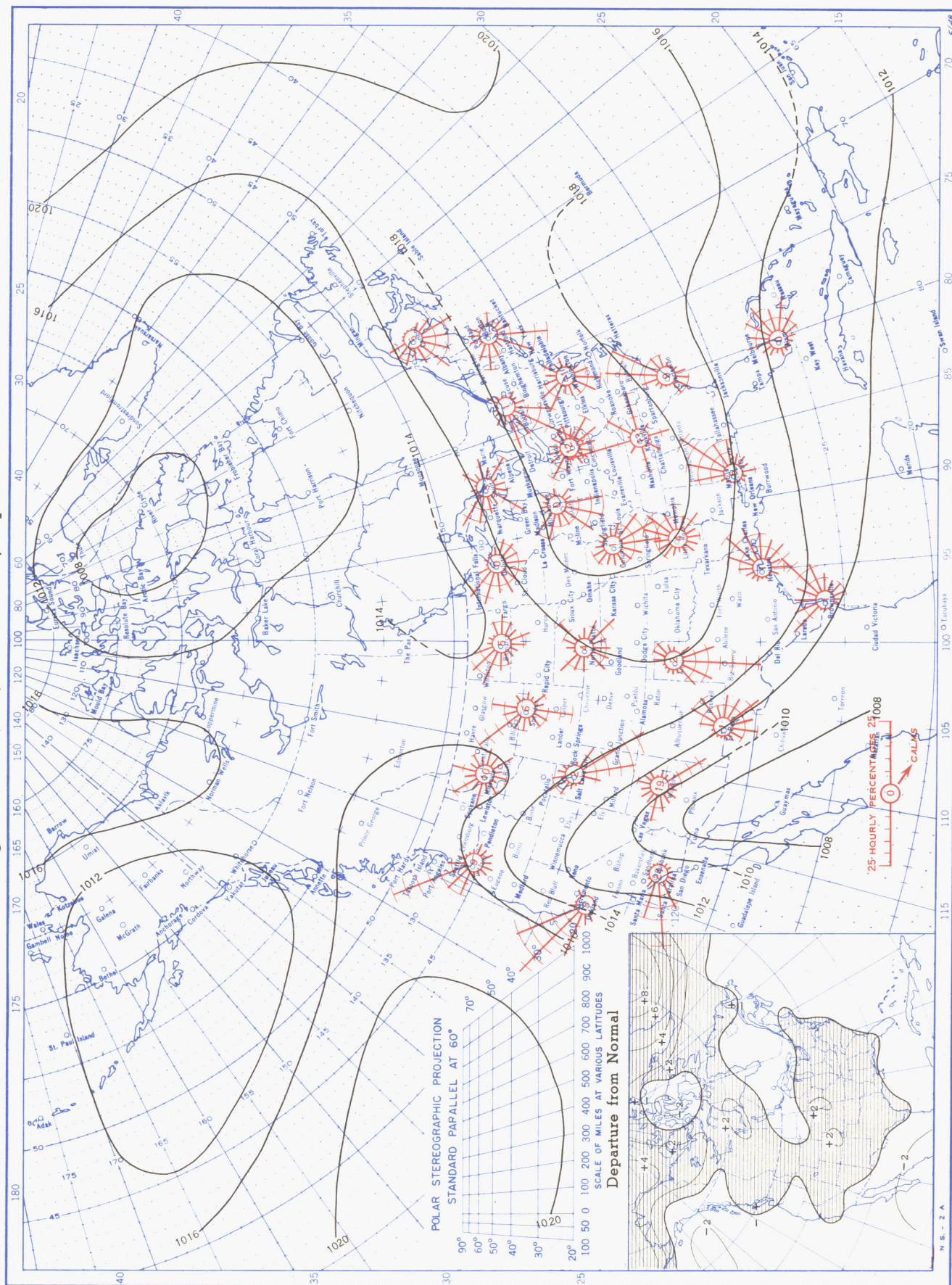
Chart X. Tracks of Centers of Cyclones at Sea Level, September 1952.



Circle indicates position of center at 7:30 a. m. E. S. T. See Chart IX for explanation of symbols.



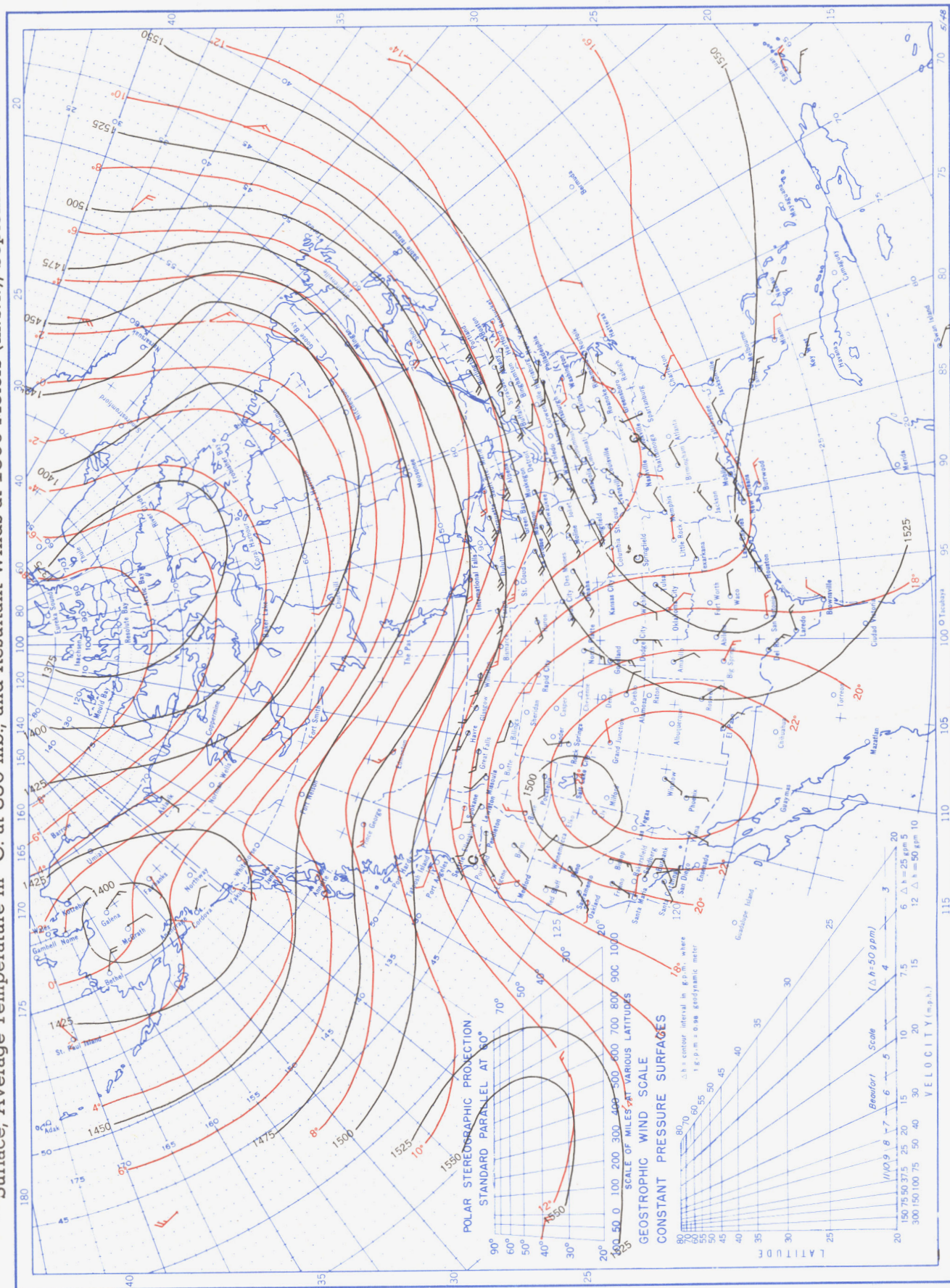
Chart XI. Average Sea Level Pressure (mb.) and Surface Windroses, September 1952. Inset: Departure of Average Pressure (mb.) from Normal, September 1952.



Average sea level pressures are obtained from the averages of the 7:30 a. m. and 7:30 p. m. E. S. T. readings. Windroses show percentage of time wind blew from 16 compass points or was calm during the month. Pressure normals are computed for stations having at least 10 years of record and for 10° inter-sections in a diamond grid based on readings from the Historical Weather Maps (1899-1939) for the 20 years of most complete data coverage prior to 1940.



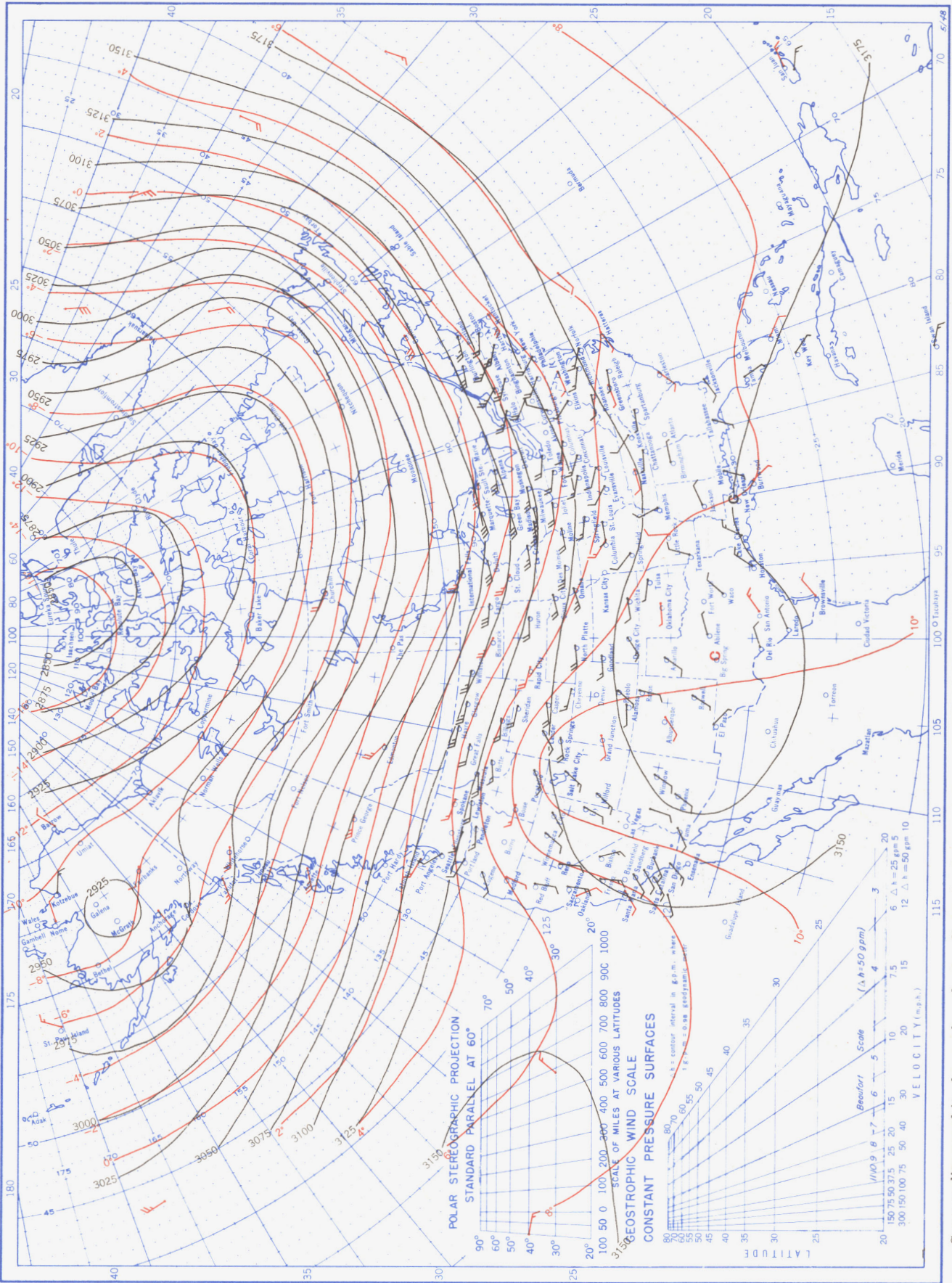
Chart XII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 850-mb. Pressure Surface, Average Temperature in °C. at 850 mb., and Resultant Winds at 1500 Meters (m.s.l.), September 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawinsonde observations at 0300 G. M. T.



Chart XIII. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 700-mb. Pressure Surface, Average Temperature in °C. at 700 mb., and Resultant Winds at 3000 Meters (m.s.l.), September 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins taken at 0300 G. M. T.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T. those shown in red are based on rawins at 0300 G. M. T.

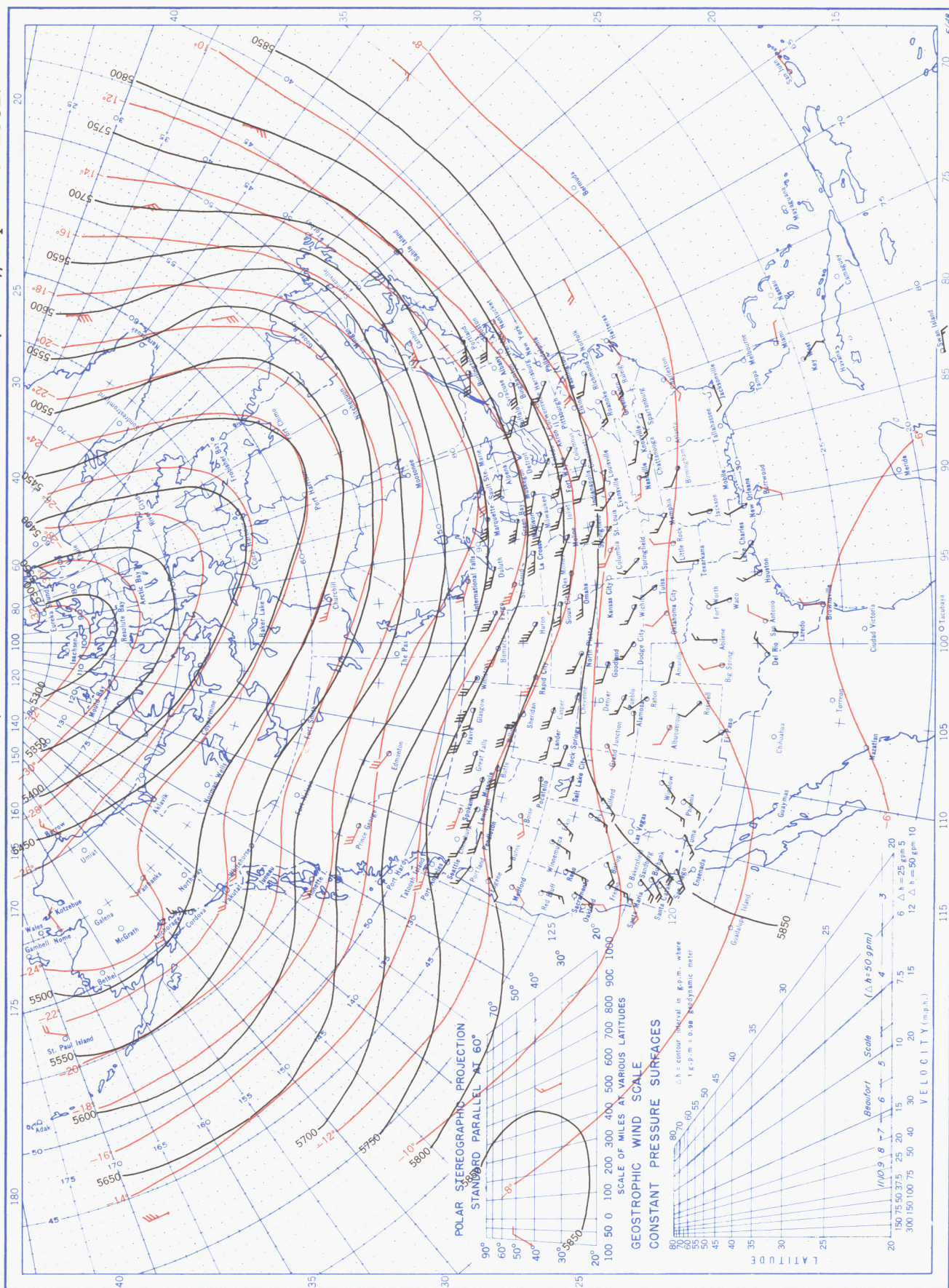
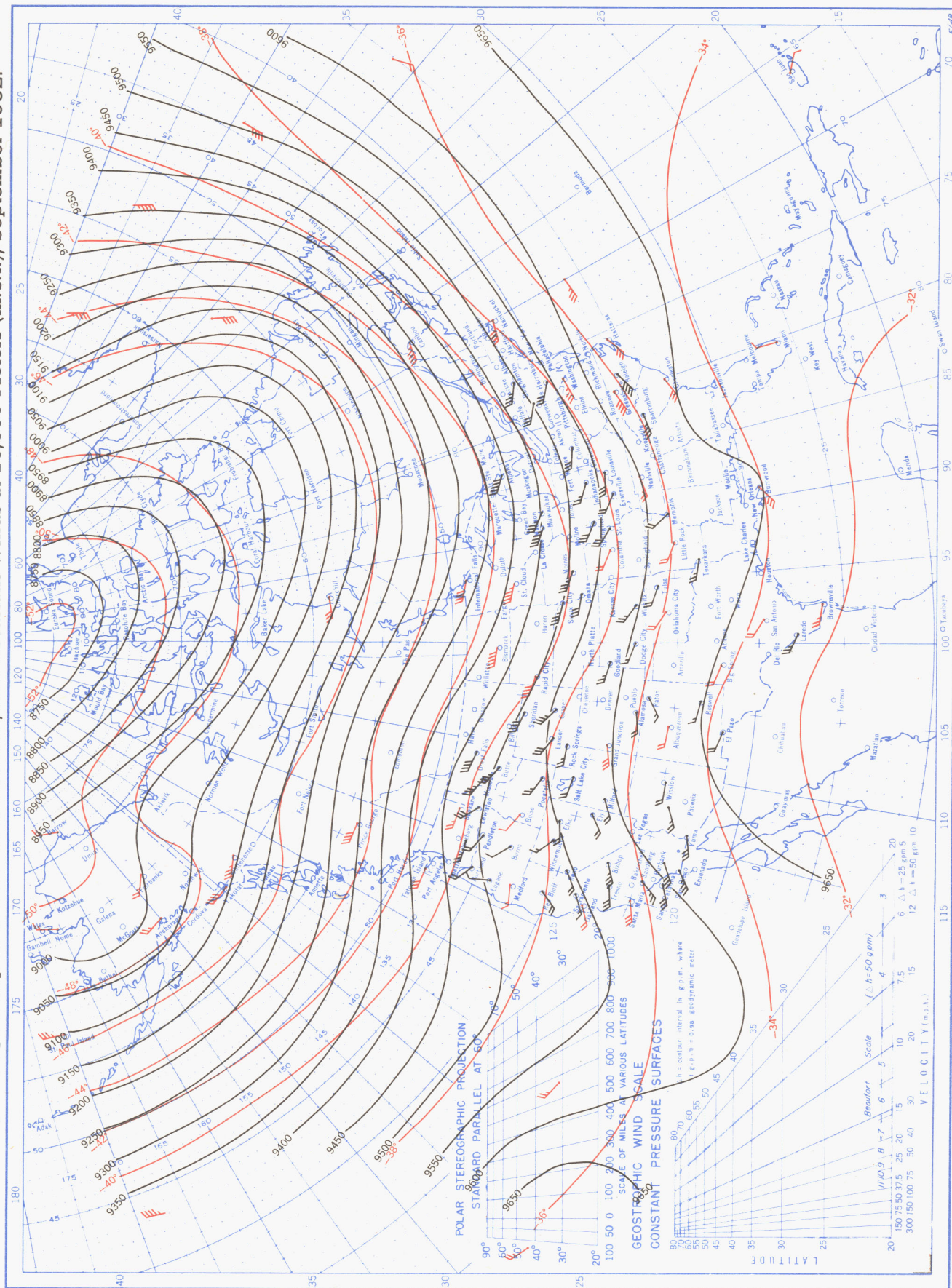




Chart XV. Average Dynamic Height in Geopotential Meters (1 g.p.m. = 0.98 dynamic meters) of the 300-mb. Pressure Surface, Average Temperature in °C. at 300 mb., and Resultant Winds at 10,000 Meters (m.s.l.), September 1952.



Contour lines and isotherms based on radiosonde observations at 0300 G. M. T. Winds shown in black are based on pilot balloon observations at 2100 G. M. T.; those shown in red are based on rawins at 0300 G. M. T.